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A comparison of relative value units in revision hip versus revision knee arthroplasty

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ABSTRACT

The purpose of this study was to compare the: 1) RVUs; 2) lengths-of-surgery; 3) RVU per minute between revision hip (THA) and knee (TKA) arthroplasties; and 4) perform an annualized surgeon cost analysis. Using the ACS-NSQIP from 2008 to 2015, 8081 revision TKAs, 7233 THAs were compared. Revision THA had greater mean RVUs (30.27 vs. 27.10 RVUs, $p < 0.001$), operative times (152 vs. 149 min, $p < 0.001$), and RVU/minute (0.3 vs. 0.2 RVUs per minute, $p < 0.001$). Cost analysis yielded and annual $89,922.73 difference. Revision THA, therefore, is reimbursed at a significantly higher "hourly rate," when compared to revision TKA.

1. Introduction

Relative value units (RVUs), implemented in 1992, are used in the United States to determine physician reimbursement.[1] Their values are based on the recommendations of a 1988 study performed at Harvard by Hsaio et al.,[2,3] which was supported by the Healthcare Financing Administration (now Centers for Medicare and Medicaid Services, CMS). The study was conducted in response to concerns that the growth rate of Medicare spending on physician services was much higher than the growth rate of the general economy.[2] In contrast to the existing fee-for-service model, this newer system aimed to standardize reimbursement across all physician services based on its quantification of the resources needed for each service required.[2,3]

The current RVU system that CMS now bases reimbursement on, accounts for three components: work, costs, and liability. The work component (work RVU), includes the time spent rendering the service as well as the intensity of effort required during that time.[2,4] The other two components represent estimated practice costs and professional liability insurance. Physician work represents about half of the total RVU and thus its largest constituent.[5] To code for a particular procedure or service, Current Procedural Terminology (CPT) codes are used as a universal system. There is an RVU designation associated with each CPT code, which is multiplied by a conversion factor to determine the CMS fee-for-service.[1] Many private payers also use this system as the basis for their reimbursement.[5]

Since its implementation, there has been criticism surrounding the RVU-based reimbursement system. In theory, the work RVU for a procedure or service should be proportional to the time, technical skill, physical and mental effort, and psychosocial stress associated with the corresponding physician service.[2] However, these measures are difficult to quantify and a discrepancy continues to exist between compensation for cognitive and procedural services.[6,7] Additionally, it remains unclear if the work component of the RVU adequately correlates with physician effort. Some have found evidence of increasing RVU designation with increasing procedural complexity.[6,7] Others, however, have found discrepancies between indicators of physician work involved a procedure and the RVUs assigned to it.[8–11]

The ability of the RVU system to accurately reflect physician effort may vary between specialties, and to our knowledge, there has been limited analysis of this relationship in orthopaedics. Revision total hip (THA) and total knee (TKA) arthroplasties have been increasing over the past few decades[12]; in the current literature about 18% of THAs and 8% of TKAs are revised.[13] Revision THA and TKA is thus a large factor in the workload of joint reconstructive orthopaedics and overall healthcare cost.[14] Therefore, the purpose of this study was to assess the use of RVUs in revision THAs and TKAs. Specifically, we compared: 1)

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RVUs; 2) operative times; and 3) RVU per unit time between revision THA and TKAs. We also performed: 4) an annualized reimbursement difference analysis for a single surgeon.

2. Methods

2.1. Database

The American College of Surgeons National Surgical Quality Improvement (ACS-NSQIP) database was used to identify patients who underwent revision hip arthroplasty or revision knee arthroplasty between 2008 and 2015. The ACS-NSQIP is a nationally validated database that retrospectively collects 135 clinical variables from hospitals throughout the United States and worldwide.[15,16] The data is collected and verified by a trained surgical clinical reviewer, to ensure accuracy and quality.[17]

2.2. Current Procedural Terminology codes

Current Procedural Terminology (CPT) codes are maintained by the American Medical Association and serve as universal identifiers of discrete services. These codes can also link procedures to physician reimbursement. In this study, CPT code 27134 was used to identify revision THA cases, while CPT code 27487 was used to identify revision TKA cases.

2.3. Revision arthroplasty procedure selection

Revision THAs and TKAs were analyzed in this study due to their substantial contribution to overall spending by CMS.[14] The average hospital charges for revision TKA and THA are around $50,000, with revision THA having slightly higher cost. A total of 59,500 revision TKAs and 45,000 revision THAs were performed in 2009, which is expected to increase in congruence with primary total joint reconstructions.

2.4. Annual cost difference analysis

An annualized cost difference analysis was performed at an individual surgeon level for revision THAs and TKAs. This was calculated using 8 h of operative time per day, and an estimated 160 operative days per year (365 days per year, less 104 weekend days, less 14 vacation days, less 5 federal holiday, less 1/3 remaining days for non-operative services). Assuming similar operative times between revision TKA and revision THA, a surgeon can complete either 3 revision TKAs or 3 revision THAs. Centers for Medicare and Medicaid Services (CMS) reports an RVU conversion factor of $35.8887/RVU. Dollar amounts per minute of operative time for both revision THA and TKA were calculated based on this conversion factor and the calculated RVU per minute. This value was multiplied by the mean case time to yield the dollar amount per case. Daily amount per case was then calculated based on per-case reimbursement times and the number of cases on average that can be completed in 8 h per day. Per day case reimbursement was multiplied by the estimated 160 operative days per year, to yield possible yearly dollar amount reimbursement differences for exclusive performance revision THA and TKA.

2.5. Relative value units analysis

Work relative value units were extracted from the NSQIP database and identified using the variable name “WORKRVU.” RVUs are updated continuously based on the recommendations of physician committees.[18] Therefore, the RVU designation of the CPT codes did not remain constant over the seven years of procedures included in the study—the RVU value of the CPT code at the time the procedure was performed was used in the analysis.

2.6. Operative time analysis

Operative times were extracted from the NSQIP database and identified using the variable name “OPTIME”. For both cohorts, cases with operative times less than 30 min or greater than 480 min were excluded, as these recorded operative times were likely errors (i.e., negative, zero, or extreme, such as 1227 min, values). A 30–480 min operative time range was used to capture at least 99% of the data from each initial surgical cohort.

2.7. Revision total hip arthroplasty patient selection

CPT code 27134 identified 7298 revision THA cases performed between 2008 and 2015 in the NSQIP database. A total of 65 cases with operative times less than 30 min or greater than 480 min were excluded, yielding 7233 cases (99%) for analysis. A total of 3878 women (54%) underwent revision THA, while 3347 men (46%) underwent revision THA. Gender was not identified for 8 cases. The mean age was 66 years (range, 19–89 years).

2.8. Revision total knee arthroplasty patient selection

CPT code 27487 identified 8126 revision TKA cases performed during the same time period. A total of 45 cases with operative times less than 30 min or greater than 480 min were excluded, yielding 8081 cases (99%) for analysis. A total of 4752 (59%) women and 3324 men (41%) underwent revision TKA. Gender was not identified for 5 cases. The mean age was 66 years (range, 18–89 years).

2.9. Data analysis

Mean operative times, mean RVUs, and mean RVUs per minute were calculated using Microsoft Excel (2013 Microsoft Office Professional Plus; Redmond, WA). The RVU/minute of each cohort was calculated using the RVU assigned to the case divided by its operative time. The mean RVU, mean operative time, and RVU/minute of revision THA was then compared to that of revision TKA. The threshold p value for statistical significance was < 0.05. All statistical analyses were performed using SPSS version 24 (International Business Machine Corporation, Armonk, New York).

3. Results

3.1. Mean relative value units

The mean RVU for revision THA was 30.27 (range, 30.13 to 30.28). The mean RVU for revision TKA was 27.10 (range, 26.91 to 27.11). Revision THA had a significantly greater RVU than that for revision TKA ($p < 0.001$).

3.2. Mean operative time

The 7233 revision total hip arthroplasties (THA) had a mean operative time of 152 min (range, 30–475 min). The 8081 revision total knee arthroplasties (TKA) had a mean operative time of 149 min (range, 30–475 min). Revision hip arthroplasty mean operative time was found to be significantly longer ($p < 0.001$).

3.3. Mean RVU per minute

The mean RVU per minute for revision THA was 0.25 (range, 0.06 to 1.01), while the mean RVU per minute for revision TKA was 0.22 (range, 0.06 to 0.90). The mean RVU per minute of revision THA was significantly higher than revision TKA ($p < 0.001$, Table 1).

Table 1
RVUs, operative times, and RVU/Minute for revision THA and TKA.

Parameters	Revision THA Mean (Range)	Revision TKA Mean (Range, SD)	P-value
Total (N)	7233	8081	
RVU	30.27 (30.13–30.28)	27.1 (26.91–27.11)	$p < 0.0001$
Time (minutes)	152 (30–475)	149 (30–475)	$p < 0.05$
RVU/minute	0.25 (0.06–1.01)	0.22 (0.06–0.90)	$p < 0.0001$

3.4. Cost difference analysis

The mean reimbursement rate for revision THA was $8.97 per minute (0.25 RVU/minute * 35.887 dollars/RVU). The mean reimbursement rate for revision TKA was $7.90 per minute (0.22 RVU/minute * 35.887 dollars/RVU). Revision THA was therefore reimbursed at an average rate of $1363.77 per case ($8.97/minute * 152 min/case), while revision TKA was reimbursed at an average rate of $1176.43 per case ($7.90/minute * 149 min/case). Therefore, there was a difference of $187.34 per case. Assuming that 3 cases are performed in an 8-hour day, performing revision THAs exclusively would result in $562.02 greater reimbursement per day than would from performing only revision TKAs. Given the estimated 160 operative days per year (see methods above), a surgeon performing revision THAs vs TKAs would receive an $89,922.73 increase in reimbursement per year (Table 2).

4. Discussion

The RVU aims to provides compensation that is proportional to the time, skill, mental and physical effort, and psychosocial stress that the physician must expend in order to provide a service.[1–5] Currently, there is limiting and conflicting evidence of the correlation between physician work involved in a providing a service and the number of RVUs assigned to it.[6–11] It is important to understand and address inconsistencies in reimbursement, as they have the potential to impact the supply of physician services.[19,20] In this study, we found that revision hip arthroplasty was a longer procedure than revision knee arthroplasty (152 min vs. 149 min, $p < 0.05$), however by only 3 min. It was also found that revision THA was associated with a higher RVU allocation (30.27 vs. 27.10, $p < 0.001$). Furthermore, we found revision hip arthroplasty to be compensated at a significantly higher rate than revision knee arthroplasty (0.25 vs. 0.22 RVU/minute, $p < 0.0001$). This would result in a reimbursement difference of $562.02 per day, or $89,922.73/per year, for revision THA compared to revision TKA.

We acknowledge certain limitations of this study. Operative time may not be a perfect indicator of physician work, as it does not account for preoperative or postoperative services, nor does it take into consideration variation in physician skill or operating room staff present. However, the ACS-NSQIP is a large database with inputs from a diversity of surgical centers, which minimizes these effects. Further, it is limited to 90 day postoperative data, and does not include other information that is pertinent to determination of physician work, such as long term preoperative and postoperative care.

Like this study, several other studies have found inconsistencies in RVU-based physician reimbursement. A similarly designed study by Shah et al.,[8] which also used the ACS-NSQIP database, demonstrated poor correlation of RVUs with several indicators of physician work including individual LOS, operative time, and patient mortality. Another ACS-NSQIP study in abdominal surgery by Schwartz et al.[10] found that emergent procedures were associated with identical RVUs to their elective counterparts, despite the fact that the emergent procedures likely required more physician effort due to higher rates of complication and mortality. In addition, the authors of the present study[11] conducted an analysis comparing primary and revision hip arthroplasty, which found that revision THA was compensated at a lower rate than primary THA despite their higher level of complexity. Analogous findings were seen when comparing RVU use between primary and revision TKA,[21] total ankle arthroplasty,[22] and posterior segmental instrumentation of vertebral segments.[23]

A few studies have, however, found correlations between RVUs associated with physician services and indicators of physician effort. A study in pediatric congenital heart surgery by Jenkins et al.[7] also demonstrated correlation between work RVUs and several indicators of case complexity, including length of stay, total hospital charges, and in-hospital mortality. This study, however, was published in 1998 using data from 1992, and there have many updates to the RVUs since then. Another analysis by Little et al.[6] found that RVUs did correlate with operating times in 59 common pediatric surgeries. However, only outpatient surgeries and surgeries requiring less than one day of inpatient care were considered, so these findings may not be applicable to more complex procedures or in adults who have higher prevalence of comorbidities. In adult plastic surgery, Nguyen et al.[24] found that increasing RVUs were correlated with increased risks of overall and surgical site complications, which may be indicators of long-term physician work. However, RVUs were not predictive of reoperation or mortality, which are also related to physician work and may suggest an interaction of other factors that are not captured by the RVU system.

Table 2
Annualized Cost Analysis for Primary vs. Revision TKA.

Parameters	Revision THA	Revision TKA
RVU/minute	0.25	0.22
$/minute	$8.97	$7.90
$/case	$1363.77	$1176.43
Cases/day	3	3
$/day	$4091.31	$3529.29
Daily Cost Difference	$562.02	
Annualized Cost Differences	$89,922.73	

5. Conclusion

Relative value units have been used to determine physician reimbursement since their implementation in 1992. This reimbursement system was intended to provide compensation that better correlated with physician work involved in providing a service. In this study, we found that revision THA is associated with significantly more RVUs and longer operative times than revision TKA, but also has RVU per unit time. These findings are substantial, because despite an only 3 min of longer operative time, the RVU/minute difference could result in a reimbursement difference of $562 per day, or roughly $90,000/per year. Given that physician reimbursement for a service may affect the rate at which that service is provided,[19,20] it is important to understand and address inconsistencies. Further, orthopaedists can use this information to balance their time, finances, and practices. Ultimately, this data should be used to help re-vamp the RVU reimbursement system in order to assist in containing healthcare costs and provide better quality care for patients.

Conflicts of interest

Nipun Sodhi, BA: None, Sarah E. Dalton, BS: None, Peter A. Gold, MD: None, Luke Garbarino, MD: None, Hiba K. Anis, MD: None, Jared M. Newman, MD: None, Bilal Mahmood, MD: None, Anton Khlopas, MD: None, Assem A. Sultan, MD: None, Nicolas S. Piuzzi, MD: None, Michael A. Mont, MD: AAOS; Abbott; Cymedica; DJ Orthopaedics; Johnson & Johnson; Mallinckrodt Pharmaceuticals; Micropor IP; NIAMS & NICHD; Ongoing Care Solutions; Orthosensor; Pacira; Peerwell; Performance Dynamics Inc.; Sage; Stryker; Kolon TissueGene.

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